Center Innovation Fund: LaRC CIF

Ultra-Low Noise Vertical Takeoff and Landing, or Development of an Uber Self-Flying, Helipad-Capable, Quiet V-ESTOL Personal Transporter Integrated Flight Demonstrator

Completed Technology Project (2016 - 2017)

Project Introduction

Several aspects of this research are completely unique compared to prior attempts to achieve low noise vertical lift solutions, and are an artifact of the incredible opportunity that electric propulsion offers.1. A unique type of vertical lift propulsor is being designed/analyzed/developed to push blade passage frequency harmonics above the human audible range, while also having low tip speeds to limit the other low broadband noise components of community noise. Typically these two requirements would be conflicting and mutually exclusive, however, use of distributed electric motors enables small propulsors to be designed in this way, with tight integration across the airframe. This strategy is shown in the figure to right, comparing the new 20,000 Hz and 285 ft/sec propulsor to 1.5’ and 9.7’ diameter propellers which have blade passage harmonics at the peak human hearing frequencies along with almost twice the tip speeds (which results in higher broadband noise). A FY17 deliverable includes rapid testing of this propulsor.2. Use of these small propulsors, each capable of 25 lbf thrust, enables their use in far more distributed ways than merely using propellers or fans. This enables advanced concepts to be developed that leverage airframe shielding to a much greater extent for further noise reduction, along with propulsor positioning to achieve directional reflectivity that causes the remaining noise to be focused upwards, and away from the community. Additionally, use of more extreme distribution enables greater spacing across the airframe which provides additional opportunities to ensure robust control across hover and transition flight regimes. New fixed-wing configuration approaches (which also achieve ~5x the Lift/Drag ratio of existing helicopters) are being developed to best leverage these new propulsors to create dramatically improved vertical lift solutions, while also avoiding open prop/rotors that are a danger for close proximity operations. Sub-scale indoor hover testing will investigate the use of distributed thrust control.This research provides a significant potential impact, with community noise being the main obstacle for frequent urban operations. Achieving high L/D ratio and use of electricity-based propulsion also results in a ~30% reduction in operating costs, and when combined with high utilization business models with high productivity vehicles (high cruise speed), the resulting $/mile/passenger in less than half that of helicopters. Validation of these claims are beginning to be echoed by major companies we’ve reached out during this past year with Airbus just announcing a new major investment initiative into small Urban VTOL Air-Taxi's. (http://www.airbusgroup.com/int/en/news-media/corporate-magazine/Forum-88/My-Kind-Of-Flyover.html)

Anticipated Benefits

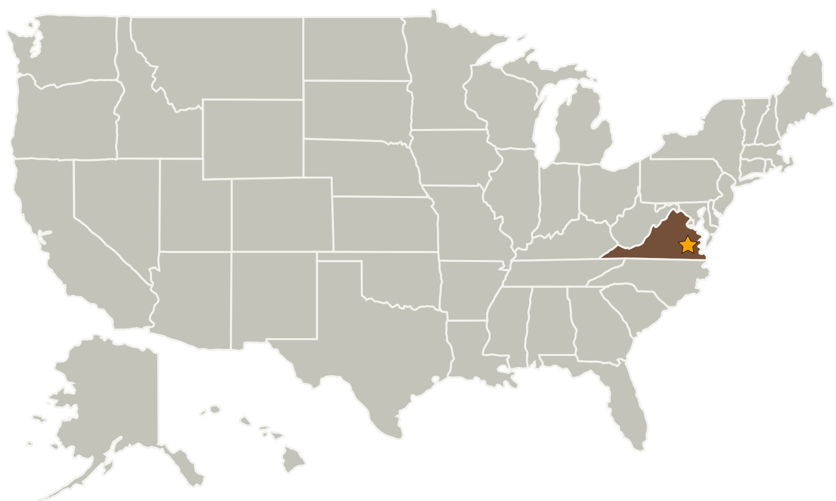
Achieve ultra-low community noise to make feasible close proximity, vertical flight operations as an accepted urban commuting solution. Global trends are pushing to the growth of mega-cities with increased urbanization; however,

Ultra-Low Noise Vertical Takeoff and Landing, or Development of an Uber Self-Flying, Helipad-Capable, Quiet V-ESTOL Personal Transporter Integrated Flight Demonstrator

Table of Contents

average speeds across cities are slowing down as transportation solutions fall behind, limiting productivity and future growth. As cities have progressed, they've grown upwards to achieve increased density; similarly, transportation options need to also expand upwards to embrace three dimensions. Only vertical flight capabilities offer the potential to achieve rapid door-to-door travel with limited infrastructure and effectively no cost highways on-demand. But current solutions (helicopters and tilt-rotors) have been limited to noisy, expensive, complicated, uncomfortable, and relatively dangerous vehicle solutions which are shunned by communities. Vertical flight needs to be completely re-thought due to a transformative shift in propulsion (electric) and control (autonomy) technologies which fundamentally change how these aircraft can be designed, and what capabilities they possess. A new type of vertical lift propulsor is being designed/analyzed/developed to ideally match up to electric motor characteristics, with unique acoustic characteristics that offer the potential for breakthrough community noise.

Primary U.S. Work Locations and Key Partners



Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Langley Research Center (LaRC)

Responsible Program:

Center Innovation Fund: LaRC CIF

Project Management

Program Director:

Michael R Lapointe

Program Manager:

Julie A Williams-byrd

Principal Investigator:

Paul M Rothhaar

Co-Investigator:

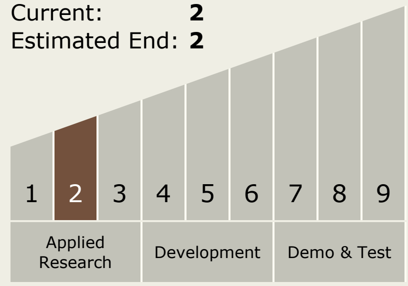
Mark A Moore

Organizations Performing Work	Role	Type	Location
★Langley Research Center(LaRC)	Lead Organization	NASA Center	Hampton, Virginia
Aero Lift Express	Supporting Organization	Industry	
Army	Supporting Organization	US Government	Washington, District of Columbia
UnRealWorx	Supporting Organization	Industry	

Primary U.S. Work Locations
Virginia

Technology Maturity (TRL)

Start: **2**
Current: **2**
Estimated End: **2**



Technology Areas

Primary:

- TX15 Flight Vehicle Systems
  └ TX15.1 Aerosciences
    └ TX15.1.4 Aeroacoustics

Target Destination

Earth